RECONSTRUCTION AND QUANTIFICATION OF NEURONAL MORPHOLOGY

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ABSTRACT

The human brain with all its faculties and intricacies has fascinated many generations of researchers [1] and will likely be the final frontier of science. Understanding the principles underlying the brain's higher-order cognitive functions is indeed a major challenge and will profoundly impact our views on what defines a human being. On a more down-to-earth level, knowledge of the structure, function, and development of neuronal cells and networks is of crucial importance in investigating potential causes of neurological and psychiatric disorders and developing effective drugs and therapies for treating them. Research in this area is increasingly relying on imaging and gives rise to large amounts of image data. The need for advanced bioimage informatics [2] and neuroinformatics [3] solutions for analyzing these data is therefore rising rapidly. One of the key challenges here is the development of computational methods and tools for the study of neuronal anatomy [4]. Studying the morphological properties of neuronal arborizations first requires converting the usually large and sparse image data into a more parsimonious representation that captures the essential image information and is easier to archive, exchange, analyze, and compare. In the past decades, quite a number of methods have been developed for this purpose [5, 6, 7], but the quest for more robust, fully automatic, and generally applicable tools continues. The goal of this presentation is to survey the state of the art in the field for anyone interested in taking up the challenge. Relevant aspects addressed in the presentation include common image segmentation approaches for neuronal reconstruction, quantitative measures of neuronal morphology, currently available software tools, and morphology databases.

Index Terms— Neuronal reconstruction, image segmentation, quantitative morphology, neuroinformatics.

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